Microwave Induced Direct Bonding Of Single Crystal Silicon Wafers

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We have heated polished single-crystal silicon wafers in a single mode microwave cavity to temperatures where surface to surface bonding occurred. The absorption of microwaves and consequent heating of the wafers is attributed to the inclusion of n-type or p-type impurities into these wafers. A TM_{010} standing wave mode was used to irradiate samples of various geometry's at positions of high magnetic field. This process was conducted in vacuum to exclude the effects of a plasma. The ratio of incident power to reflected power from the cavity was monitored and maintained at low values by frequency tuning the signal source. Various power-time profiles were used to rapidly or slowly raise the temperature and achieve bonding in a controlled manner. Qualitative mechanical testing of the bonded wafers indicated reasonable bond strengths. The mechanism for this bond formation is not presently well understood. We speculate that impurity bonds (e.g. Si-O-Si) or direct silicon to silicon bonds are formed and are responsible for the formation of the bonded structure.

In summary, this initial study suggests that the inclusion of impurities in single crystal silicon enhances its microwave absorption (loss factor) to a point where heating and bonding silicon wafers without an intermediary can be accomplished in minimal time.